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be expressed as 12.5. Usually, however, percentages so expressed are not, as in this instance, exact. They are approximations and being approximations they will not invariably add to 100.0 unless they are adjusted so as to make them add to that. A simple illustration will show this. Take the following in which each item is exactly one-third of the total:

| Items. | Amounts. | Per Cent. of Total. |
|---|---|---|
| A......... | 422 | 33.3 |
| B......... | 422 | 33.3 |
| C......... | 422 | 33.3 |
| Total........ | 1,266 | 100.0 |

Here the percentages add to 99.9, yet each percentage is as nearly exact as it can be when carried out to only one decimal place. If, in order to make these percentages add to 100.0, one of these percentages is changed to 33.4 it becomes less exact than it was before, the exact percentage in each instance being nearer 33.3 than 33.4.

Although the constituent percentages in the above example add to 99.9 the percentage for the total is nevertheless given as 100.0 mainly for the reason that 100.0 is the true percentage and absolutely exact. It is just what it purports to be, viz., the percentage which the total is of the total. Furthermore, expressed as 100.0, it has the practical advantage of indicating to the reader that the percentages given above are the percentages which the items form of the total, 1266.

In view of this fact that percentages which have been adjusted so as to add to 100.0 are less exact than they were before the adjustment was made the Bureau of the Census some years ago deliberately abandoned the practice of adjusting percentages. Incidentally, however, the change was in the interests of economy as well as accuracy, for when, as is so often the case in census work, a large number of items are given, the adjustment, which must be made according to prescribed rules, involves considerable clerical labor.

Joseph A. Hill.

## MECHANICAL DEVICES IN EUROPEAN STATISTICAL WORK.

To those familiar with the development of statistical methods it is well known that the introduction of mechanical devices for performing the clerical work has been one of the important factors in extending the range and improving the quality of the results in recent years. Not only is accuracy improved, due to the fact that machines do not make mistakes, a point in which they differ in an astonishing degree from the human organism, but of equal or greater importance is the extension in the quantity and complexity of statistical work which the mechanical methods make possible, the mere labor of which would have been out of the question under hand tabulation and computation. In view of the lead taken by the United States in this branch of work, which may be called an American contribution, and of the fact that so many of the devices have been the product of "Yankee ingenuity," some data on the increasing use of such appliances in Europe may be of interest. Two circular inquiries sent out by the *Deutsches Statistisches Zentralblatt* * of Berlin to the various statistical bureaus and offices of Europe, one at the beginning of 1910 and the other at the beginning of 1914, have brought together some fairly complete figures. The following table, collated and condensed from this journal, shows the progress in the four years, amounting to nearly a doubling of the number of machines of all types in use.

NUMBER OF MACHINES BY CLASSES IN EACH COUNTRY.

| Country. | Tabulating and Counting Machines. | | Adding Machines. | | Computing Machines. | | Computing Cylinders, Tables, etc. | |
|---|---|---|---|---|---|---|---|---|
| | 1910. | 1914. | 1910. | 1914. | 1910. | 1914. | 1910. | 1914. |
| Austria | 10 | 10 | 39 | 53 | 34 | 33 | 7 | 19 |
| France | 25 | 25 | 1 | 1 | 1 | 1 | 3 | ......... |
| Germany | ......... | 9 | 52 | 102 | 96 | 132 | 19 | 79 |
| Luxemburg | ......... | ......... | ......... | 1 | 5 | 5 | ......... | ......... |
| Belgium | ......... | ......... | 2 | 1 | 1 | 1 | 1 | 1 |
| Holland | ......... | ......... | 4 | 7 | 2 | 2 | ......... | 1 |
| Switzerland | ......... | ......... | 6 | 16 | 3 | 14 | 5 | 8 |
| Sweden | ......... | ......... | 1 | 1 | 3 | 4 | ......... | ......... |
| England[1] | ......... | ......... | ......... | ......... | (4) | ......... | (3) | ......... |
| Denmark | ......... | 1 | ......... | 4 | ......... | 9 | ......... | 8 |
| Norway | ......... | 1 | ......... | ......... | ......... | 2 | ......... | 4 |
| Totals | 35[2] | 46 | 105 | 186 | 145 | 203 | 35 | 120 |
| Grand Total | ......... | ......... | ......... | ......... | ......... | ......... | 319 | 555 |

[1] Figures for England are omitted from the totals, no reports from that country having been received for 1914.

[2] See text below.

The numbers in the table are the totals of all appliances in use in each country by the various official bureaus engaged in statistical work, whether national, district, or municipal. A brief indication of the character and origin of the devices included in each class (also taken from the *Zentralblatt*) will make the table more intelligible. Reference is made to the figures for 1914. The machines referred to in the first column include three types. The 10 in use in Austria are the old style Hollerith electrical tabulating machine, invented by the American engineer of that name and first used in tabulating the results of the Eleventh Census of the United States. They indicate by means of clock dials and do not add or print. The 11 machines in Germany, Norway, and Denmark are the improved

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*See *Deutsches Statistisches Zentralblatt*, 1910, columns 117, 151, 219; 1911, column 25; and 1914, column 233.

Hollerith type, printing automatically both sub-totals and totals.* The figures given include only the tabulating machines proper, and not the complement of punching and sorting machines. A total of 402 of the latter were in use.

The 25 machines ascribed to France are of the type called *classicompteur imprimeur*, designed by M. Lucien March, the head of the statistical work of the French government, and, so far as indicated, not used elsewhere. The device serves the same general purpose as the Hollerith machine, but differs much less from hand methods. It may be described as virtually a multiple counting machine with 60 sets of rolls and as many keys, one to each set. Depressing any key counts one on the corresponding set of number discs. The keys are named arbitrarily according to the data to be recorded, either a fact or a combination of facts; for example, in population tabulation, one key might represent "males," another, "native-born males, 20–30 years," or the like. For recording more than 60 separate facts or combinations, more than one machine is used. The totals are printed at any time, by depressing a lever, and the counters all reset at zero.

The second column gives the figures for the adding machines, which are familiar in every American business office, and require little comment. Of the total of 186 reported in use in the different countries, 153, or nearly five sixths, are distributed among the following American makes: Burroughs, Comptograph, Comptometer, Comtator, Standard, and Wales. Nearly all of these print automatically, both the numbers added and the totals. The remaining 23 machines represent 10 different styles, partly foreign, partly "origin not indicated," and largely small, inexpensive, non-printing devices.

But if America may be said to have practically preëmpted the field in the first two types of instruments, the reverse is the case with the last two varieties. The "computing machines" are designed to perform all four of the fundamental arithmetical operations, but are chiefly used for multiplication and division. They all depend on the basic principle of repeated additions for multiplication and repeated subtractions for division. The 203 machines are distributed among 20 makes, all apparently foreign to the United States, and represent two general systems of arrangement, the "Thomas" and the "Odhner." At least two patterns are imported and extensively used in this country, the "Brunsviga" and the "Millionaire." The latter is a Swiss product, arranged according to the "Thomas" system, but represents an improvement over all similar machines in that the repetition of the addition and subtraction operations to secure products and quotients is automatic, the result for each figure being obtained by a single turn of a single crank handle. None of these machines print.

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* For a description of the early device, see the paper by Dr. Hollerith in the *Journal of the Statistical Society* for 1894, p. 678. Some description of the improvements introduced in connection with the Thirteenth Census of the United States will be found in the *Quarterly Publications of The American Statistical Asso.* for December, 1909, and a fuller, popular account in the *Scientific American* of September 11, 1909.

The devices classed in the fourth column of the table are a miscellaneous group of left-overs and include mainly slide-rules of different patterns and "tables" of various descriptions and systems.

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## MORTALITY STATISTICS OF RECENT YALE GRADUATES.

Yale men are decidedly good mortality risks, especially during the years immediately succeeding graduation. This conclusion is indicated by the statistical analysis that is the subject-matter of this note. The contrary view expressed by Professor Newton of Yale, that college graduates exhibit a high death rate in the first years after graduation, would not seem to be borne out by a scrutiny of the mortality record of the twenty classes last graduated from Yale College.

These twenty classes, the first graduated in 1894 and the last in 1913, aggregated 5,870 men at graduation. Their aggregate mortality from time of graduation to 1914 was 266 men, an approximate annual average of 4.5 per 1,000 risks. The annual mortality rate for males of all ages throughout the United States (registration area) in 1900 was 18.91 per 1,000, and for males 25 to 34 years of age (corresponding roughly to the mean age of these college classes during the period under discussion) 9.05 per 1,000. It is clear that these twenty Yale classes present a better record by 50 per cent. than the average group of males of their age in the United States.

This might be expected, for college men are recruited among the mentally and physically virile, from whose ranks a continual elimination process during the college course weeds out the unfit. In other words, the college graduate has been subjected to a process of highly developed artificial selection. A fairer criterion by which to test these classes, therefore, would be the expected mortality of males of corresponding age according to the American Mortality Experience Table. This table was constructed some time ago, when the general mortality was probably more unfavorable than today; on the other hand, it was based upon a medically selected class of risks, practically all of them males, and is a recognized mortality standard for actuaries today.

According to the American Experience Table, the mortality among the 5,870 men who graduated from 1894 to 1913 would have amounted by 1914 to 480 men. The actual mortality, as we have seen, was 266, or only a little over one half the expected total.

The twenty classes show considerable variations in this respect, illustrating the fact that individuals and small social units frequently display different characteristics under substantially similar conditions. The following table gives the actual and the expected mortality of each class, and the percentage of actual to expected: